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ANALYSIS OF ERTS IMAGERY OF WYOMING AND ITS APPLICATION TO EVALUATION  
OF WYOMING'S NATURAL RESOURCES

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16. Abstract <p>The Wyoming ERTS investigation has been hindered only slightly by incomplete ERTS data sets and lack of coverage. Investigators have continued their work begun during "Preliminary Data Analysis". Efforts to map cultural development, vegetation distributions, and various geomorphologic features are under way. Several other studies are nearing completion or "first stage" results.</p> <p>Dr. D. L. Blackstone has completed his tectonic analysis of the Rock Springs area in which he has isolated two linear features that may be very significant with regard to the regional structure of central Wyoming. Dr. R. B. Parker is finishing a study of the fracture systems of the Wind River Mountains. The fracture-map which he has constructed from ERTS interpretations, contains a great deal of structural information which was previously unavailable. Dr. R. S. Houston is nearing completion in his mapping of the Precambrian metasedimentary and metavolcanic terrain of the Granite Mountains where interpretation of ERTS supporting aircraft data has revealed deposits of iron formation.</p>			
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Figure 2. Technical Report Standard Title Page

Second Bimonthly  
ERTS Type I Report

R. S. Houston  
R. W. Marrs

OBJECTIVES OF THE CONTRACT

The principal objectives of the Wyoming program is to apply the ERTS satellite imagery and supporting aircraft and ground-control data to the study of geological, botanical, and agricultural features in the state of Wyoming. The resulting information aids in the achievement of practical goals in inventory and management of natural resources.

AVAILABLE DATA

ERTS imagery for all of western Wyoming and portions of eastern Wyoming have now been received in one form or another. Most of the data products, with the notable exception of the 9" x 9" paper prints, are of high quality and are quite adequate for our investigation. However, we have received only a few of the requested 70 mm negative material and none of the data shipments received thus far conform entirely to the standing order. All shipments lack one or more of the requested data types. We presently have data only from the first and second set of satellite passes, both of which were in August, 1972. We have not yet received satellite coverage for our prime test site, the Medicine Bow area.

We have received the data from our moderate-altitude support flight (Mission 213) which was flown in September, 1972. The flight was very successful and the data are of excellent quality. This aircraft data will undoubtedly provide much of the needed control and correlation information for the ERTS interpretations.

## WORK SUMMARY

Project investigators at the University of Wyoming and at Goddard Space Flight Center are presently working with the available ERTS-1 imagery and the aircraft data. They have been actively involved in these analysis during the entire report period (September-October, 1972). Dr. R. S. Houston has continued his work in the igneous and metasedimentary Granite Mountains area of central Wyoming (Houston and Marrs, September, 1972). He is completing a small scale map of the area near Barlow Gap, Wyoming, where iron formation was discovered by use of aircraft imagery, and is presently utilizing aircraft imagery (184, Sept. 1971; 213, Sept. 1972), U-2 imagery (Oct. 1971) and ERTS MSS imagery to map the Granite Mountains area of central Wyoming. The various types of imagery are compared to determine their utility in mapping Precambrian terrain (i.e. granite-gneiss terrain vs. metasedimentary-metavolcanic rock terrain). Location of the metasedimentary-metavolcanic rock terrain allows predictions to be made on the location of other possible iron-formation areas.

Dr. Houston also attended the seminar on "Preliminary Findings from Analysis of ERTS Observations" at GSFC on September 29, 1972. He and Dr. Nicholas Short, a co-investigator for the Wyoming investigation, presented a summary of the results of the Wyoming program at that seminar. That presentation will be included in the proceedings of the seminar which are presently being assembled for publication at GSFC.

Dr. R. B. Parker has completed a major portion of his study of the large-scale fracture systems of the Wind River Mountains. Dr. Parker used aircraft data in making a detailed analysis of fracture patterns for one strip across the Wind River Range. He then made a similar interpretation

for the entire range, using ERTS imagery. The results have not yet been thoroughly field checked, but extremely good correspondence of the ERTS and aircraft data interpretations and confirmation of some features in the field suggests that the ERTS imagery provides a great deal of information about the regional fracture systems.

Dr. Parker is preparing a separate report on his work in the Wind River Mountains. This report will be submitted to NASA/GSFC in late November, 1972.

Dr. D. L. Blackstone has completed analysis of the tectonic elements in the area of the Rock Springs Uplift using ERTS imagery. He has located two major linear elements on the ERTS imagery which may be the surface expressions of deep-seated structural elements. Dr. Blackstone has analyzed these linear elements with respect to their regional significance and has prepared a separate report on his findings. If Dr. Blackstone's tentative identification proves correct, the discovery of these features will certainly represent a major contribution to the geology of Wyoming.

Mr. Marrs, the Wyoming project coordinator, is engaged in an attempt to map cultural development using the ERTS imagery. Present attempts are aimed at mapping agricultural and urban development using color-addition and densitometry as tools for enhancing or delineating subtle contrasts. Information from the ERTS imagery with regard to this development should provide data for environmental impact studies, potential geologic hazards, land use inventories, and resource and potential development studies. Thus far, attempts to map towns and urban development from the ERTS data have been unsuccessful. Attempts to study the agricultural and water resources development have been more encouraging. The study was begun only recently, and results are not yet conclusive.

Roy Breckenridge, the research associate with the Wyoming ERTS investigation has been concentrating on geomorphologic interpretations of the ERTS data. He has studied much of the imagery for western Wyoming and has derived a considerable amount of valuable information from the ERTS images in several areas. The ERTS imagery has been especially successful in studies of erosion cycles, such as paleodrainages and stream captures in the Bighorn Basin (September 29th Wyoming Report).

Mr. Breckenridge is now compiling a glacial map of western Wyoming from ERTS. Field checks and comparison with literature show surprising accuracy. The results of this study will be presented in a separate paper, probably in December. Analysis of aircraft imagery has revealed some new areas of periglacial features (patterned ground) as well as new areas of landslide activity.

Mr. Francis Redfern, a research assistant with the Wyoming investigations is attempting to use the ERTS imagery to map vegetative types in the Medicine Bow Mountains and Laramie Basin. His study includes large areas of forest and grassland with all intermediate communities. He has been somewhat hampered in his investigation by lack of ERTS data in his study area. We have not yet received 70 mm positive or negative material for the Laramie-Medicine Bow area. Consequently, Mr. Redfern has not yet been able to employ color-additive techniques for his interpretations. Mr. Redfern has used both aircraft data and field work to check his interpretations of the ERTS imagery. Results from his investigation have been relatively insignificant thus far, but we anticipate that proper coverage from consecutive satellite passes and in the proper formats will

enable him to make some of the desired distinctions. Mr. Redfern has experimented with color-additive enhancement of vegetation in other ERTS images of Wyoming. The results have been moderately encouraging. He has tentatively identified several color-additive combinations which appear to enhance some vegetation patterns. More experimentation and work in control areas where the vegetation distributions are known, will be necessary before any specific results can be reported.

#### CONFORMANCE WITH WORK SCHEDULE

Phase I (Data analysis preparation) and Phase II (Preliminary data analysis) of the Wyoming ERTS program are now complete. The original data analysis plan has been re-evaluated and a slightly modified data analysis plan has been submitted for the continuation of the study. The standing-order data requirements are sufficient as specified by the last standing-order change, but the data products thus far received do not conform entirely to the standing order. Consequently, some of the required data products are not available and the work must be scheduled around these deficiencies. We are now continuing with Phase III (Continuing data analysis) of the program pending approval of the revised "Data Analysis Plan" by the Contracting Officer. The Wyoming ERTS-1 program is funded through December, 1973, and work under Phase III of the program will continue through that time.

At the beginning of the "Preliminary Data Analysis" portion of the investigation, we were approximately one month behind schedule because the first ERTS images were not received until September, 1972. However, a considerable amount of extra time was spent in analysis of aircraft data in the early part of the contract period when the ERTS images were

not available. This early work with the aircraft data should result in a more efficient application of the aircraft data to later ERTS analysis. This should implement the Phase III portion of the study.

#### EXPLANATION OF PROBLEMS

The only problem that is significantly hindering the progress of the program is lack of appropriate data products. Most of the data shipments received do not include the 70 mm positive and 70 mm negative material necessary for color-additive viewing and reproduction. We have not received copies of many of the images contained in early-pass sequences and still do not have complete, cloud-free coverage, for the state of Wyoming. Some data shipments do not contain all available bands of each image.

A second problem which has caused some difficulty is the poor or variable quality of some of the bulk data products. All of the 70 mm negatives received thus far are too dark and are difficult or impossible to use for color-additive viewing and super-position filtering. The 9-in. prints are commonly over-exposed or appear slightly out of focus. The positive transparencies (both 70 mm and 9 in.) are generally of good quality. However, it has been noted that some frames show considerably more detail than others. This may be a function of atmospheric transmission, or it may be the result of poor processing. We have received some positive transparencies which are definitely out of focus.

#### ADEQUACY OF FUNDS

Expenditures to date are well within the proposed budget. Projection of expenditure rates indicates that there will be sufficient funds for those investigation items allowed in the contract, and that the budgeted



funds will precisely meet the needs.

In the previous Type I report (Houston and Marrs, September, 1972) we expressed concern regarding the adequacy of funds if it were necessary to purchase the color prints needed for the investigation. Since that time our special request for color prints of the aircraft-support photography has been approved. This alleviates much of the problem, but we are still concerned about the availability of ERTS color composites. These, apparently, can be obtained for a few areas only and are not available to ERTS investigators even in limited quantities. We feel that standard color composites are needed for a few selected frames of ERTS imagery, and would like to have these provided (if possible).

#### PERSONNEL

There have been no changes in University of Wyoming personnel during the September-October report period. However, Mr. Harold Mathews has joined Dr. Short at NASA/Goddard and has consented to cooperate with Dr. Short and University of Wyoming personnel as a project co-investigator. Mr. Mathews' background is in soil science, and his skills should complement those of the other investigators in the Wyoming multidisciplinary study.

#### PLANNED WORK FOR NEXT REPORT PERIOD

During November and December, 1972, we expect to begin Phase III (Continuing Data Analysis) of the Wyoming ERTS-I program. This will include continuation of the geologic investigations of Drs. Blackstone, Houston and Parker and Mr. Breckenridge. Each of these investigators is presently completing a study and will submit a special report within the next two months. Mr. Marrs and Mr. Redfern will continue their studies

In urban development, agriculture, and forestry.

It is anticipated that the requested ERTS coverage of the Wyoming test sites will be received in the next two months. Receipt of this data should allow the investigators to employ the full capability of the interpretative equipment and techniques and to begin work in the areas best suited to the individual studies.

#### COOPERATION WITH STATE AGENCIES

Wyoming project investigators, with the encouragement of NASA, have met with representatives of many state and federal agencies to acquaint them with the ERTS program and discuss applications of remote sensing to particular problems. Response to these meetings has been remarkable. Most agencies have expressed a desire to use ERTS imagery or aircraft data in some way. Many interested groups have visited the Wyoming remote sensing lab to see the data, equipment and interpretation techniques. The Department of Economic Planning and Development has approached the University with a request to have tests made of the utility of remote sensing in state planning. They have outlined several problems in specific areas of interest which they feel might be solved using ERTS data.

Cooperation with the various state agencies and discussion of individual problems has led University investigators to realize the broad scope of ERTS applications and the immediate need to apply such data to the practical problems facing these organizations.